ON SOME GENERAL CONNOTATIONS OF MAGNETISM.

BY PLINY EARLE CHASE.

Messrs. Baxendell (Proc. Manchester Lit. and Phil. Soc., 1865–6) and Bloxam (Proc. Meteorolog. Soc., Nos. 28, 32), have pointed out certain interesting resemblances between the curves of magnetic declination and those of rainfall, or of the "changes that occur in the aqueous element—that is to say, changes from and to the solid, fluid and vaporous states." But Mr. Glaisher (Proc. Meteorolog. Soc., No. 33, p. 23) infers from a careful discussion of six years' observations at the Royal Observatory, Greenwich, that "there does not seem to be any connection between the diurnal movements of the declination magnet and the diurnal fall of rain. The curve of diurnal rainfall, from all the years, seems in some way connected with the position of the sun; the least frequency of rain, and the smallest falls, take place during the morning hours, whilst the sun is ascending; the greatest frequency and most rain take place in the afternoon hours, whilst the sun is descending."

An examination of the curves or of the tables from which they are constructed, at Girard College, St. Helena, Cape of Good Hope, Hobarton, Toronto, Nertschinsk, Pekin, Kew, Greenwich, Makerstoun, and elsewhere, shows that there is an intimate relation between the variations of the several meteorological elements, temperature, elasticity of vapor, gaseous pressure, pressure of the wind, barometric pressure, electricity, magnetic declination and inclination, vertical and horizontal force, and that all these phenomena depend either directly or indirectly upon solar action. Whether that action is simple or multiform in its origin, whether the consequent changes materially modify each other by their mutual interaction, and whether the magnetic forces are specific or derivative, celestial or terrene, cosmical or local, are questions which are still *sub judice*. Major-General Sabine (Phil. Trans., vol. 153, p. 307), after noticing "the concurrent evidence of the three observatories of Toronto, Hobarton, and Kew, for the existence of . . . an increase of the dip and of the total force, and a deflection of the north end of the declination magnet towards the west, in both hemispheres, in the months from October to March, as compared with those from April to September," says, "it seems

difficult to assign to such effects any other than a cosmical cause. The greater proximity of the earth to the sun in the December compared with the June solstice most naturally presents itself as a not improbable cause; but we are as yet too little acquainted with the mode of the sun's action on the magnetism of the earth to enter more deeply into the question at present."

That the coincidence which is here suggested with the commendable caution and modesty of a truly philosophic spirit, is the indication of a *vera causa*, seems to me indubitable. In Mr. Broun's recently published discussions of the "diurnal variation of the magnetic declination at Trevandrum, near the magnetic equator, and in both hemispheres" (Trans. R. S. of Edinburgh, vol. 24), data are collated for some more than usually satisfactory general averages of magnetic variations, which are interesting, both on account of their incidental confirmation of Sabine's hypothesis, and on account of the confidence which may be reasonably attached to all evident deductions from properly authenticated mean values. Ten stations are chosen for comparison, five of which are in north, and five in south (magnetic) latitude, the mean latitude coinciding nearly with the magnetic equator, as is shown by the following table.

Station.	Geographic Latitude.		Longitude.		Magnetic Dip.	
	° ′	° ′	h. m.	h. m.	° ′	° ′
1. Makerstoun,	55 35 N.	. . .	. . .	0 10 W.	71 30 N.	. . .
2. Toronto, . .	43 40 "	. . .	. . .	5 17 "	75 15 "	. . .
3. Simla. . .	31 6 "	. . .	5 9 E.	. . .	41 40 "	. . .
4. Bombay, . .	18 56 "	. . .	4 51 "	. . .	18 44 "	. . .
5. Madras, . .	13 4 "	. . .	5 21 "	. . .	7 40 "	. . .
6. Trevandrum,	8 31 "	. . .	5 8 "	. . .	. . .	2 30 S.
7. Singapore, .	1 19 "	. . .	6 56 "	. . .	. . .	12 40 "
8. St. Helena, .	. . .	15 57 S.	. . .	0 23 "	. . .	22 0 "
9. C. of G. Hope,	. . .	33 56 "	1 14 "	. . .	. . .	53 20 "
10. Hobarton, .	. . .	42 53 "	9 50 "	. . .	. . .	70 20 "
Totals, . .	172 11 N. 92 46	92 46 S.	38 29 E. 5 50	5 50 W.	214 49 N. 160 50	160 50 S.
÷ 10	79 25		32 39		53 59	
Average, .	° ′ 7 54 N.		h. m. 3 16 E.		° ′ 5 24 N.	

According to the second edition of the "Admiralty Manual for ascertaining and applying the deviations of the compass caused by the iron in a ship" (1863), the magnetic equator crosses the meridian of 49° E. (3h. 16m. E.), in (geographical) latitude 10° N. The above average latitude is therefore nearly an arithmetical mean between the corresponding magnetic latitude and the magnetic dip.

The "ranges of the mean diurnal variations of the needle freely suspended in the direction of the magnetic inclination," are given in the following table (*op. cit.*, p. 684).

Month.	Makerstoun.	Toronto.	Simla.	Bombay.	Madras.	Trevandrum.	Singapore.	St. Helena.	Cape of G. Hope.	Hobarton.
	′	′	′	′	′	′	′	′	′	′
January, . .	1.85	1.49	1.22	1.73	1.63	2.06	2.64	3.45	3.08	4.05
February, .	2.25	1.54	1.16	1.39	0.96	1.48	2.89	4.81	4.56	4.28
March, . .	2.94	2.30	2.69	2.57	2.36	0.79	1.67	4.57	4.35	3.30
April, . . .	3.56	2.48	3.88	4.07	3.71	1.67	1.13	3.06	2.80	2.60
May, . . .	3.48	3.03	4.27	4.72	4.69	2.90	2.24	2.45	2.34	1.56
June, . . .	3.67	3.08	4.37	4.69	4.77	3.06	1.83	3.00	1.93	1.28
July, . . .	3.35	3.05	3.90	4.39	4.57	3.06	1.94	3.17	1.99	1.36
August, . .	3.42	3.48	4.36	5.42	4.75	3.64	2.60	3.32	2.75	1.87
September, .	3.30	2.51	3.99	5.38	5.28	3.31	2.07	2.22	2.56	2.65
October, . .	3.01	1.74	2.36	2.59	2.37	1.27	2.38	4.11	3.55	3.80
November, .	2.39	1.58	0.98	0.90	1.50	2.14	2.97	3.75	3.81	4.08
December, .	1.91	1.33	0.78	1.16	1.17	2.33	2.90	3.28	3.26	4.13
Mean, . .	2.93	2.30	2.83	3.25	3.14	2.31	2.35	3.43	3.08	2.91

By combining these values in various ways the general means in the first column of the following table are obtained. Those of the second column are derived in a similar manner, from Kaemtz's table of the barometric means at Paris, Strasburg, Halle, Berlin, and St. Petersburg. The height of the barometer is given in millimetres.

I.

	Var. of Dec.	Barom. mean.		Var. of Dec.	Barom. mean.
January, . . .	2′ 32	757.91	July, ...	3′ 08	755.85
February, . . .	2′ 53	757.86	August, . . .	3′ 56	755.98
March, ...	2′ 75	755.96	September, . .	3′ 33	756.87
April, ...	2′ 90	755.02	October, . . .	2′ 72	756.77
May, ...	3′ 17	755.90	November, . .	2′ 41	755.56
June, ...	3′ 17	756.36	December, . . .	2′ 22	756.09

		Var. of Dec.	Barom. mean.
	II.		
Mean of	March and September (equinoctial),	3′ 04	756.41
"	one month from equinoctial months,	2′ 93	756.40
"	one month from solstitial months,	2′ 74	756.30
"	June and December (solstitial),	2′ 70	756.22
	III.		
"	December and January (perihelion),	2′ 27	757.00
"	November and February,	2′ 47	756.71
"	October and March,	2′ 74	756.37
"	September and April,	3′ 11	755.95
"	August and May,	3′ 36	755.94
"	July and June (aphelion),	3′ 12	756.10
	IV.		
"	November to February, inclusive (perihelion),	2′ 37	756.88
"	Sept., Oct., Mar., April (equinoctial),	2′ 92	756.16
"	May to August, inclusive (aphelion),	3′ 24	756.02
	V.		
"	Mar. and April (1st, or N. vernal equinox),	2′ 82	755.49
"	Jan. to June, inclusive, " "	2′ 81	756.50
"	Sept. and Oct. (2d, or N. autumnal equinox),	3′ 02	756.82
"	July to Dec., inclusive, " "	2′ 89	756.19
	VI.		
"	Oct. to Mar., inclusive (perihelion),	2′ 49	756.69
"	April to Sept., inclusive (aphelion),	3′ 20	756.00
	VII.		
"	Spring,	3′ 06	755.63
"	Summer,	3′ 74	756.06
"	Autumn,	2′ 70	756.40
"	Winter,	1′ 88	757.29
	VIII.		
"	Warm semester,	3′ 48	756.14
"	Cool semester,	2′ 20	756.55
"	Year,	2′ 85	756.35

The predominance, under some circumstances, of the lunar over the solar magnetic action, which was pointed out by Sabine (Silliman's Jour. [2] xix. 424), is confirmed by Broun (*op. cit.*, p. 678), who also finds (p. 690) that the most brilliant auroras are observed near the moon's opposition, notwithstanding the brightness of the moonlight. The observations at Trevandrum concur with those at other stations, in showing that

the sun's disturbing action on the equatorial portions of the magnetic meridians is greatest during the hottest part, and least in the coolest part of the day, while the moon's has two nearly equal maxima, about the times of its upper and lower culminations, and two minima, near the times of its rising and setting.

Although the deductions which I have thus brought together may contain little that is absolutely new, they have the advantage of a more general basis and a more compact presentation than those which are usually given in the discussions of local observations, and any legitimate inferences to which they may jointly lead, will, therefore, be entitled to more than ordinary consideration. To my own view, it seems that a very cursory examination of their bearings would justify the conclusions to which I have been hitherto led by more special study (*ante*, vol. ix, pp. 356–360, 367–371, 427–440; x, 97–104, 151–166); but for fear of an undue bias from the natural and unconscious leaning of prejudice towards arguments which favor a preconceived theory, I propose to follow, as impartially as may be, Faraday's clue of the "lines of force."

In the first column of the above synopsis of general means there is a remarkable consistency, except in the mean of June and July, which corresponds almost precisely with that of April and September. The anomaly is perhaps owing to the predominance of the solstitial influence in June and July, of the combined northern thermal and reactionary influences in August, and of the N. autumnal equinoctial influence in September. In the subsequent four and six months' groupings the aphelion excess is very clearly shown.

In the groupings which are based on the distance of the earth from the sun (III, IV, VI), and upon the semi-annual thermal means (VIII), there is a uniform opposition between the march of the numbers in the first and that in the second column, increase of barometric pressure corresponding to decrease of declination disturbance, and *vice versâ*. But in the groups which are specially affected by equinoctial or solstitial influence (I, II, V, VII), this uniformity is broken, and in one instance (II) the contrariety is even changed into an agreement. In each of these discrepant cases it will be seen that the magnetic basis is much broader than the barometric, which is limited by the insular climate of Europe, and that the anomaly

is barometric and not magnetic, for the ordinary thermal influence on the barometer is overridden by the influences of atmospheric currents and terrestrial absorption and radiation, of which I have treated in discussing the laws which regulate the transmission and distribution of solar heat (*ante*, pp. 261–269, 309–315).

It appears, therefore, that the variations of declination are greater in summer than in winter, greater by day than at night, greater at sunrise than at sunset (see *inter alia*, Hobarton Mag. and Met. Obs., v. ii, plate 1), greater at aphelion than at perihelion, greater at the equinoxes than at the solstices, greater at the N. autumnal than at the N. vernal equinox, greater in auroras and thunder-storms than in electric calms, greater at the lunar syzygies than at the quadratures, greater at low barometer than at high barometer, greater at the theoretical hours of high tide than at those of low tide (see Sabine's and other discussions of the lunar-diurnal variations), greater at full moon than at new moon, in fine, greater in the presence than in the absence of various violent local agitations.

The existence of magnetic rays in the spectrum, and the self-registering records which demonstrate the simultaneous occurrence of disturbances in the solar photosphere and in the earth's magnetic atmosphere, seem to indicate an influence which is transmitted with a velocity at least as great as that of light;* the controlling power of thermal changes was early recognized, and Norton even submitted it to the test of calculation (Silliman's Jour. [2] vols. 4, 8, &c.); the amount of electricity contained in a single drop of water has been computed by Faraday and others, who have shown that the electric disturbances during evaporation, condensation and convection are surprisingly great;† the influence of thunder-storms and other electric meteors might reasonably have been predicted *à priori*, as soon as the intimate relations of magnetism and electricity were ascertained; Faraday sought in vain for some experimental proof

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* The magnetic relations of light suggest a reference to the (perhaps accidental) relation of light to terrestrial gravitation, which I pointed out in a former communication (*ante*, p. 269).

† The arguments by which this conclusion has been attacked do not disprove the disturbances, but they merely show that in many cases the equilibrium is restored as soon as it is broken.

of a definable connection between gravity and magnetism, a connection which had long been suspected, which was rendered increasingly probable by the resemblance of the lunar declination-curve to the regular tidal-curve, and which was verified by my numerical computations (Trans. A. P. S., vol. xiii, pp. 117–136); the increase of lunar force at syzygy and at full moon may be easily understood if we are satisfied to refer it to tidal-attraction; under the diminished pressure at low barometer there is less resistance to any disturbance of fluid motion; Arago, Ampère, Barlow, and Christie, showed that the simple rotation of bodies, constituted of any material whatever, generates magnetic currents; the use of percussion and vibration in magnetizing or demagnetizing iron bars, Leverrier's daily meteorological reports, Palmieri's observations during the recent eruptions of Vesuvius, and my experiments with merely mechanical vibrations and currents analogous to those which are constantly agitating the atmosphere (*ante*, v. ix, p. 359; x, 151, &c.), furnish abundant evidence of the effects of local agitation.

Much of the later theorizing and investigation has proceeded on Ampère's assumption, that the earth is an electro-magnet, magnetized by an electric current which flows from east to west, the current being excited by the action of the sun's heat successively in different parts of the earth's surface, as it revolves toward the east, but little has been done towards removing the difficulties which are supposed to surround that hypothesis. There is, perhaps, an increasing tendency to regard the sun as a true magnet, exciting the earth solely by its induction. But such a theory serves merely as a cloak for our ignorance. Even if the sun and earth were each solid masses of magnetized iron, the solar inductive action on the earth would be relatively no greater than that of a globular magnet, one foot in diameter, upon an iron shot, one-ninth of an inch in diameter, at a distance of one hundred and ten feet.*

Electricity and magnetism are both manifested as forces which tend to a speedy equilibrium. Whether the equilibrium is disturbed by friction, by mechanical separation, by chemical

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* See Dr. Lloyd's demonstration that "the phenomena of the diurnal variation are *not* caused by the *direct magnetic action* of the sun and moon." (Phil. Mag. [4] xv, 192–6.)

solution, by approach, by pressure, by combination, by crystallization, by revolving currents, by either of the various known methods, there is an immediate effort on the part of all the forces acting either within or upon the disturbed bodies to adapt themselves to the new conditions. If the effort is unresisted, the adaptation may be as rapid as the disturbance, and there may be no evidence of electric excitement. In all cases the amount of electric manifestation seems to depend on the amount of precedent resistance.

In ordinary electric and magnetic experiments the equilibrating or manifesting force appears to be molecular, and for many plausible reasons it has often been supposed to be the same as is exhibited under different forms as cohesion, crystallogeny, and chemical affinity. Terrestrial magnetism is a cosmical manifestation, and as a cosmical equipoising force exists in gravitation, it is difficult to conceive any cogent reason for violating the law of parsimony by supposing an additional force for accomplishing the same ends. We have seen that disturbances which are transmitted with the most various degrees of rapidity, disturbances of gravitation, of light, of heat, of motion or position relative to the sun or moon, of atmospheric moisture, of electric condition, or of simple physical rest, may be followed by magnetic displays. In the most frequent of these disturbances the motion is greater than that of undulation, involving an actual progression of aerial particles, but whether the motion be rapid or sluggish, undulatory or progressive, gravitation acts with inconceivable rapidity* towards the planes of equilibrium.

A joint consideration of the gyroscopic, viscous, elastic, centrifugal and centripetal forces which are indicated by the barometer, shows that the contour of the atmosphere is such as would be assumed if the changing motions relatively to the sun acted as disturbances, and the terrestrial gravity as a restorer of equilibrium (*ante*, vol. ix, p. 283, seq.).†

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* According to Laplace's estimate the velocity of gravity is *at least* six million times as great as that of light.

† When I first called attention to this point, I had seen only the second volume of the St. Helena Observations. I subsequently met with the first volume, containing (on p. 88) General Sabine's means of five years observations, which show a daily barometric range from + .037 to —

In the daily relations of heat to magnetism, there is an anomaly, analogous to that which I pointed out in the barometric tides. For if we take the natural division of the day, the variations of declination are greatest when the sun is above the horizon, or during the warmest half of the twenty-four hours, but if we divide by the meridian, they are greatest in the coolest half, or the morning hours. So in the year, if we divide at the equinoxes, they are greatest at aphelion, when the least heat is received from the sun, but if we divide at the solstices, they are greatest in summer, when the local heat is greatest. It may be impossible to explain these discrepancies so simply as the analogous ones in the barometric tides, but the same explanation will doubtless serve, to some extent, in both cases. The following points of coincidence may, perhaps, contribute towards a proper reference of the several disturbed motions to the disturbing body.

At syzygy and at high tide, the disturbing attraction is directly opposed to terrestrial attraction; at summer and during the day-hours, there is the same opposition, intensified by the accompanying heat disturbance; at the equinoxes the change of gyroscopic plane is most rapid; at sunrise, and at the second equinox, the motion (of rotation or of revolution, respectively), is added to that which is due to solar heat and attraction; in the aphelion semester, the land hemisphere being most directly exposed to the sun, the daily fluctuations of temperature are consequently greater, and the relative effect of those fluctuations is greater, from the fact stated by Sabine (*loc. cit.*), that the earth's total magnetic force is then more feeble; the expansion of vaporization, and the collapse of condensation are both sources of sudden and violent agitation; at full moon the night disturbance is greater than at new moon, and the average disturbance of the entire twenty-four hours is therefore greater.

The following summary gives the principal points of the generally accepted theory of terrestrial magnetism, together

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.030 = .067 in.; and an annual range from + .082 to — .053 = .135 in. These values give the barometrically formulated distance of the sun $(\frac{.135}{.067})^2 \times 22{,}738{,}900 = 92{,}313{,}146$ miles, a curiously close approximation to the 92,380,000 miles (with a probable error of ± 136,000 miles) of Newcomb's recent estimate (App. II, Washington Ast. Obs. for 1865).

with such modifications as seem to be warranted by the foregoing considerations. Although I can hardly imagine the possibility of essential change in any particular, I submit it as a merely provisional statement, subject to such future amendments as may be required by the progress of discovery.

1. The earth is an electro-magnet, magnetized by currents which are excited by the sun and by the earth's rotation.

2. Terrestrial magnetism is subject to a variety of disturbances, some of which are periodical, others irregular and occasional.

3. The principal periodical disturbances vary: 1st, with the solar hour; 2d, with the season of the year; 3d, with the relative distance of the earth from the sun; 4th, with the rapidity of the earth's orbital motion; 5th, with the rapidity of change in solar declination; 6th, with the absolute hour, in reference to magnetic meridians in the Pacific and Atlantic oceans; 7th, with the lunar hour; 8th, with the lunar declination; 9th, with the position of the principal planets (sun-spot period); 10th, with change of climate (secular variation). All these disturbances (the last, perhaps, excepted), appear to be transmitted with the speed of gravity, and they may all be grouped under two heads: 1st, change of relative position; 2d, change of relative velocity, between the disturbing and the disturbed body.

4. The principal occasional, or irregular disturbances, seem to be dependent upon, 1st, irregular variations in the light or heat transmitted from the sun; 2d, similar variations in the diathermancy or transparency of the earth's atmosphere; 3d, local accumulations of heat or cold; 4th, electric and other local meteoric changes; 5th, atmospheric or terrestrial agitation (cyclones, earthquakes, volcanic eruptions, &c.). These disturbances are, of course, transmitted with velocities varying from that of light or of electricity to that of sound-waves, or even to that of still more sluggish vibrations.

5. The periodical and the occasional disturbances are all modified by mutual interaction. The phenomena are thus complicated, and the difficulty of satisfactory investigation is largely increased.

6. The sources of disturbance are, therefore, multiform; some are celestial, and others terrene; some cosmical, and

others local in their origin. They all, however, have this common feature: each is capable of occasioning fluid currents.

7. Every disturbance of terrestrial magnetism is accompanied by a disturbance of terrestrial gravitation.

8. The gravitating atmospheric currents, which are originated simultaneously with the magnetic disturbances, become, in their turn, the source of secondary disturbances.

9. However the disturbance is produced, be it primary or secondary, periodical or occasional, there is an immediate tendency to equilibrium, and that tendency is in the direction of the terrestrial gravitation of fluids.

10. The regular disturbances by the sun's heat and attraction, combined with the rotation and attraction of the earth, produce revolving currents, analogous in form to those which circulate around ordinary magnets.

11. Similar revolving currents must be excited about the sun, and about every other rotating celestial body. Such bodies, therefore, may become, like the earth, electro-magnets, or the seats of a specific magnetism.

12. If the specific magnetism is to be measured by the intensity of the exciting disturbance, the sun may be, relatively, the weakest magnet in our system; if it is to be measured by the intensity of the equilibrating force, it is probably proportioned to the force of gravitation at the surface of the magnetized orb.

13. It seems probable that the specific cosmical magnetism, like that of a permanent magnet or of an ordinary electro-magnet, reacts inductively. But I know of no good reasons for supposing that such induction is other than a comparatively unimportant, secondary, and subordinate action.

14. The lunar primary disturbances, so far as has hitherto been ascertained, appear to belong exclusively to the first class of periodical disturbances, those which are due to change of relative position. It seems most likely, however, that there may also be lunar periodical disturbances of the second class.

15. The resemblance of the lunar diurnal magnetic curves to the normal tidal curve, indicates a close correspondence between lunar magnetism and lunar gravitation.

16. Magnetism does not seem to be, strictly speaking, a simple or independent force, but, like the central force of an eddy, the resultant of revolving currents, moving with a speed

which is, probably, at least as great as that of light, at the surface of the magnetized body.

17. Terrestrial and cosmical magnetism can be satisfactorily accounted for by the hypothesis that all the magnetic eddies are produced by the action of gravity in the restoration of disturbed equilibrium. No known force, other than gravity, has a known velocity sufficient to enable it to act promptly, as an equilibrating force, in all the known cases of magnetic disturbance.

Mr. Briggs addressed the Society, and stated that—

He had recently been considering the subject of construction of domes, having been led to do so by the proposal to inclose and cover one of the Penn Squares (228 feet square), by some temporary and light, but spacious building, for an exhibition of manufacturing industry by the Franklin Institute. He had conceived the plan of a structure, the main portion of which should be a hemispherical dome of 208 feet diameter, and this dome he had designed to be a framework in carpentry, without tie-rods or internal support, but relying for its strength and stability upon tie-bands, which should be adequate to carry the horizontal radial components which existed as tension or compression at the top and bottom ends of the rafters. The contour of the dome proposed, was rather a funicular polygon than a semicircle, but the study, when reduced to the general case, involved all forms of what might be termed a homogeneous dome.

The particular instance and application, Mr. Briggs said he had already endeavored to elucidate in as popular a way as he could, at a meeting of the Franklin Institute on Wednesday last, and a report of the remarks would appear in the Journal of the Institute at an early day, but what he wished to call the notice of the members of the Philosophical Society to, was that the general investigation of the equilibrium and strength of a homogeneous dome of an egg-shell had never been considered. The dome of equilibrium of our treatises on applied mechanics, was a transformed catenary where the load on the chain varies as φx, in place of as a constant. This curve has the same characteristic constant horizontal component as the ordinary catenary; and if a dome be constructed of this form, each part is in equilibrium, and the entire strain is to be carried by the

abutments, or by a tie-band at the bottom. In the case of an arch (or of its reverse, a suspension bridge), this disposition of the load is proper, but, in domical structure, even when of stone or brick, where the only tensional strength of each course as a band, is that derived from the friction of superimposition, and, more evidently yet, when of iron, there is no reason why all the available strength of the materials should not be employed.

In brickwork domes, hoop-iron bands laid in the courses would give immense strength.

But the great point to which he would call attention, was the want of mathematical investigation. The subject embraced not only domes and their varieties of thickness, but included a flat plate, supported on all sides (or all around), and even of this general and common case, we had no formula connecting the strength of materials (either by compression or extension), with surface and thickness.

No demonstration had shown whether the head of a cylinder should be concave, or convex, or flat.

Mr. Briggs remarked that it was probable that some student, following in the steps of M. Lamé, would solve these problems; but now they stood a reproach to "applied mechanics," that practical operations were inexplicable.

The minutes of the Board of Officers and Council at their last meeting, were read.

Pending nomination, No. 586, and new nominations, Nos. 587 and 588, were read.

General T. S. Kane offered the following preamble and resolution, which were considered and adopted:

Whereas, There is reason to believe that the Northwestern Territory, recently ceded to the United States by the Russian Government, possesses resources, in productions and naval facilities, of much greater value and importance than has hitherfore been supposed, the early development of which, by explorations in Geodesy and Natural History, is deemed to be of high importance to the interests, both of science and of commerce, therefore—

Resolved, That the officers of this Society be requested to sign and transmit to Congress a memorial, asking the earliest possible action for the commencement and execution of proper